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ABSTRACT

This study focused on the evaluation of the delivery system of five different projects supported by the National Science Foundation. Seven general factors proposed by Havelock were used to identify the difference among various delivery systems. A series of on-site visits, interviews, observations, and questionnaires were used to describe the major characteristics of the delivery system of each project. A panel of nine judges used the collected information to rate each delivery system against Havelock's factors. A two-way analysis of variance with repeated measures was used to analyze the data. Results showed that differences existed among projects in the extent to which they met the factors taken as a group. (HM)

RESEARCH PAPER #17

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EVALUATION OF IMPLEMENTATION PROJECTS SUPPORTED BY THE NATIONAL SCIENCE FOUNDATION*

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I. Introduction

During the past two years, the National Science Foundation (NSF) has supported a program of implementation activities under the auspices of the Instructional Improvement Implementation Section. The purpose of this new program is to provide assistance "to those who are concerned with the implementation of science curricula and improved instruction within their own school systems and classrooms."[1] NSF supports projects, ordinarily at colleges and universities, designed to implement major curricula at the precollege level in science, mathematics, and social sciences. Several different mechanisms are used to accomplish the desired curriculum changes. These mechanisms, called delivery systems here, provide for interactions between schools and colleges and were designed to familiarize teachers with new curricula.

II. Problem

An evaluation of five different implementation projects was carried out during 1973-74. Each project used a different delivery system to achieve its implementation objectives. The purpose of the evaluation was threefold: (1) to develop appropriate methodology for evaluating implementation projects, (2) to characterize several selected delivery systems, and (3) to learn more about the process of dissemination and utilization of science curricula.

*We wish to express our appreciation to the Project Directors who willingly assisted us in this study.

III. Procedure

A model of knowledge dissemination and utilization recently proposed by Havelock[2] provides a conceptual framework to evaluate the various delivery systems. This model portrays the implementation process as an interaction or linkage between a potential "user" and a potential "resource." The purpose of the linkage is a transfer of knowledge. It can be analyzed into five categories by the question: "Who says what to whom by what channel to what effect?" This question is applied to the current problem in Figure 1.

Figure 1

Knowledge Transfer in NSF Implementation Program

WHO	transfers WHAT	by what CHANNEL	to WHOM	to what EFFECT
University science educators supported by NSF	Science/math curricula	Varies by delivery system	Science teachers, schools	Increase scientific literacy in the USA

It is noted in Figure 1 that the "channel" for implementation varies from project to project. In one instance, it is a two-week summer workshop at a local college; in another it is a fifteen-week in-service program in a local district. The various "channels"--we call them delivery systems-- are the prime focus of this study.

Havelock has found that seven general factors appear to account for or are related to effective knowledge dissemination and utilization.[3] By applying these seven factors (criteria) to the delivery systems, a clearer picture of the strengths and limitations of the systems should be available.

Five different delivery systems were the focus of this study. All projects were funded by NSF and are typical of the implementation program started by the Foundation in 1973. A series of on-site visits, interviews, observations, and questionnaires were used to describe the major characteristics of each delivery system. These characteristics were summarized in a series of reports prepared for projects directors and NSF.

A panel of nine judges read each report and gained familiarity with each project through a series of staff discussions which occurred periodically throughout the life of the evaluation. These judges were then asked to rate each delivery system against the seven factors proposed by Havelock, et.al. A two-way analysis of variance with repeated measures was computed to determine if significant differences existed among projects and to determine the degree to which the projects, as a group, satisfied the seven qualities for successful implementation. Finally, judges' ratings were compared with several other descriptors of the several implementation modes.

IV. Results

A. Descriptions of the Delivery Systems

The five delivery systems are examples of what Havelock, et.al., term "temporary systems for promoting change." These systems are differentiated by six characteristics: users, location, time of instruction, instructors, instructional responsibility, and school district support.

What was communicated in the five systems is not essential to differentiating them, so that the curricula studied need not be discussed. A common reward was provided in all five systems.

Teachers who participated received graduate level credits from a university associated with the system. In most cases, teachers also received tuition support and some travel allowance.

The first delivery system to be discussed is the Portal School. Instruction was given to groups of elementary or secondary school teachers, usually from the same school or district. The classes met weekly after teaching hours at a local school for approximately one semester. Instructors were themselves elementary or secondary teachers who had attended training sessions at the sponsoring university and had been certified. School districts supported the Portal School by providing meeting sites, some materials, and in some cases tuition costs, which were otherwise borne by teachers. Districts made commitments with the sponsoring university to implement the curriculum studies.

The Accessible School delivery system was of a semester's duration with meetings once a week in the evening at a local junior college. Classes were taught by junior college instructors who had previously attended short training sessions at the sponsoring university. The teachers taught at local junior high schools. However, there was no district level participation.

The Off-Campus Center delivery system provided semester-long instruction for secondary teachers. Classes met weekly at night in a local school that was made available by a cooperative school district. Instructors were themselves secondary teachers who completed a master's level program at the sponsoring university. Teachers' school districts allowed the use in schools of curricular materials developed or discussed at the Off-Campus Centers, but the districts provided no financial support.

Another delivery system is represented by the Summer Workshops conducted at a sponsoring university. Each workshop presented one curriculum, and each lasted two weeks with eight hours of instruction and laboratory work per day. Instructors were university faculty, and in several workshops secondary teachers were hired as assistant instructors. No school district commitment was made concerning curriculum implementation.

The final delivery system to be discussed is a cooperative type workshop. One or two teachers in several districts were trained at the sponsoring university as resources in the curriculum to be implemented. Local workshops for teachers were conducted by instructors, expert in the curriculum prior to the beginning of the school year. During the year periodic classes were held for teachers, in which university personnel participated. School districts which participated agreed to implement the curriculum.

B. Havelock's Factors

Based on a review of nearly 4,000 studies of the dissemination and utilization process (D&U) Havelock and his associates have proposed seven general factors which account for most D&U phenomena. In Table 1 a brief description is provided of each factor as it relates to the channel through which knowledge is communicated.

[Insert Table 1 here]

Table 1

Brief Description of General D&U Factors[4]
Specific to Channel

1.	Linkage	- allows direct contact; two-way interaction.
2.	Structure	- systematic strategy; timing to fit user's problem-solving cycle.
3.	Openness	- flexible strategies; best channel allows informal communications between sender and receiver about the innovation.
4.	Capacity	- capacity of channel to carry maximum information; accessibility to maximum number of users in minimum time.
5.	Reward	- channel which can convey feedback (+ and - reinforcement); most effective channel has best reward history for sender and receiver.
6.	Proximity	- easily accessible channel, familiar to the user.
7.	Synergy	- the number and diversity, continuity and persistence of different channels used to transmit the message.

C. Rating Scales

A five-point rating scale was used to rate each delivery system on each of the seven general factors. The anchor descriptions for each point are listed below.

5 - uses to fullest extent possible
4 - system permits substantial amount
3 - typifies somewhat
2 - little more than chance
1 - creates a negative situation

Cell means for the nine judges were computed to determine the fit of each medium with each of the seven D&U factors. Although these means are potentially useful in a formative sense to project directors, they are not crucial for this paper and are not reported here.

Row and column mean ratings were computed and are presented in Table 2. Both factor and delivery system are ranked in descending order.

[Insert Table 2 here]

The results of an analysis of variance[5] of factor and delivery system differences is presented in Table 3. Both main effects are significant at the $p < .01$ level, while the interaction effect is not significant. Apparently, differences do exist among projects in the extent to which they meet the factors taken as a group vary significantly in their characterization by the Havelock factors. They are rated relatively high on proximity, capacity, and structure, but rather low on openness and synergy.

[Insert Table 3 here]

An inter-rater reliability coefficient was determined using the intraclass correlation procedure proposed by Guilford.[6] A consistency estimate of .62 was obtained.

Table 2

Mean Ratings
D&U Factor by Delivery System

Factor	Delivery System					
	Portal	Collaborative	Centers	Accessible	Workshop	
Proximity						3.51
Capacity						3.31
Structure						3.29
Linkage						3.18
Reward						3.07
Openness						2.82
Synergy						2.78
	3.54	3.43	3.02	2.87	2.82	3.14

Table 3

Analysis of Variance
Single Group Two-Factor Design
--Both Factors Repeated

Source of Variation	d.f.	Sum of Squares	Mean Square	F	Error Term
Factors	6	19.26	3.21	3.75*	(FxJ)
System	4	27.00	6.75	6.93*	(SxJ)
Judges	8	31.53	3.94		
Factors x Systems	24	17.53	.73	1.55	(FxSxJ)
Factors x Judges (FxJ)	48	41.14	.857		
Systems x Judges (SxJ)	32	31.17	.974		
Factors x Systems x Judges (FxSxJ)	192	93.50	.47		
TOTAL	314				

*p < .01

The development of a judgmental criterion expands our arsenal of tools for program evaluation. It provides an additional data-point to use in real world program evaluations. This "multiple data-point method" permits us to characterize the delivery systems on several different criteria. Several of these characteristics are shown in Table 4.

[Insert Table 4 here]

Cost per teacher participation hour is computed by dividing the cost of a project by the total number of man-hours of instruction provided. It is a straightforward calculation, although budget figures are considerably more difficult to obtain. The figures in Table 4 are based on expenditure estimates with an accuracy of $\pm$ 5%.

Use rates--that is, the percent of teachers using the innovation the year following the training--are more variable. In some instances, it is a new course, e.g., BSCS biology, while in others it may be a single instructional unit, e.g., a rock identification lab.

Satisfaction of teachers with the training is in response to a questionnaire given to participants following the workshop. Nearly all (94%) teachers expressed a positive response to questions dealing with the general effectiveness of the delivery systems. Although the magnitude of these figures should be viewed with caution because of unknown bias in the responses, teachers apparently find this program useful.

Although five cases do not provide many data points, there appears to be no strong correlation among the variables. For example, spending more money does not necessarily insure increased use rates. Each criterion seems to be a different way of evaluating the delivery system.

Table 4

Delivery System Characteristics

System	Criteria			
	D&U Factor Rating	NSF Cost Per Teacher Participation Hour	First Year Use Rates	Participant Satisfaction Rating*
Accessible	2.87	$ 9.50	84%	100%
Centers	3.02	$17.10	67%	90%
Collaborative	3.43	$ 7.80	96%	90%
Portal	3.54	$ 1.50	48%	98%
Workshop	2.82	$ 3.20	51%	93%
Mean	3.14	$ 7.80	69%	94%

*Percent indicating positive reaction to delivery system

Perhaps as more projects are evaluated using these procedures, some trends will emerge. Meanwhile, it is important to note that variations do occur and that the mean figures best characterize this implementation program. Participants were very satisfied, judges rated the program about average, cost is $7.80 per TPH, and first year adoption rate is around 70 percent.

V. Discussion

A major purpose of this study was to develop additional criteria that could be used to evaluate NSF sponsored implementation projects. We have shown that discrimination among various types is possible using judges and the Havelock factors. Further study is needed to examine the relationships between this quality criteria and other evaluative criteria--for example, adoption rates, cost, persistence of implementation, and participant satisfaction. Some evidence has been provided (Table 4) which indicates the existence of independent criteria. Because of this possibility, it is our belief that a multiplicity of variables should be used in program evaluations.

This study has also highlighted several characteristics of the Foundation's implementation program. The projects vary considerably on training costs (range $1.40 to $17.00) and on use or adoption rates (51% to 96%). The projects are conducted near the teachers (proximity), carried out by competent staff (capacity), and organized to fit users' adoption needs (structure). On the other hand, several shortcomings of the program emerge. NSF supported projects of this type are usually single mode (low synergy), and do not permit two-way interaction between resource and user (low openness).

Project directors and the National Science Foundation need to consider these strengths and limitations as they seek ways to increase program effectiveness. Hopefully, the information generated in this and other evaluation studies can serve accountability needs of NSF and provide a basis for improved decision making.

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